

Non-destructive investigation of the morphology of tissue regenerative scaffolds with high resolution X-ray tomography

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The long-term success of tissue-regenerative implants comprising synthetic materials depends largely on the host response. Amongst the key factors influencing the inflammatory foreign body response elicited by cardiovascular and cell transplantation devices is the surface structure and porosity of the scaffold. The knowledge and control of the scaffold micro-architecture during development and manufacture is crucial to ensure dimensions that allow the ingrowth of cells and tissue as well as vascularisation, e.g. by capillaries and arterioles.

High resolution X-ray tomography is an emerging non-destructive investigation technique which allows to study the 3D morphology of various types of objects without the need for sample preparation. In an X-ray tomography scan, a sequence of X-ray projection images of an object is acquired from different directions, which allows to reconstruct the internal structure. In high resolution X-ray tomography, the internal structure of the object can be resolved down to the micrometer level. This allows to investigate the microstructure and microporosity of the object.

Here, we present recently obtained results in the investigation of the microstructure of electro-spun scaffolds by means of high resolution X-ray tomography. The samples were scanned at the Centre for X-ray tomography (UGCT) and the resulting projection data was reconstructed using the tomographic reconstruction package Octopus. We illustrate the use of phase contrast correction algorithms incorporated in Octopus, which deal with the presence of wave-related effects in X-ray imaging at a micrometer scale. The obtained volumetric data is analysed by means of the 3D analysis package Morpho+ to obtain information about the overall sample porosity, the spatial distribution of the porosity, the dimensions and the interconnectivity of the pores as well as the fibre diameter and its distribution. The obtained results illustrate that the combination of high resolution X-ray tomography and advanced 3D analysis tools lead to a powerful tool for the quantification of the structural properties of scaffolds at a micrometer scale.

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